INDIVIDUAL-TO-INDIVIDUAL EEG CONVERSION USING SWIN TRANSFORMER

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1. ABSTRACT

In cognitive and computational neuroscience, the challenge of generalizing models trained on data from one subject to another arises primarily from the inherent individual differences in brain activity captured through electroencephalography (EEG) signals. EEG is a non-invasive method for recording brain electrical activity, widely used in applications such as brain-computer interfaces (BCI), cognitive state monitoring, and the diagnosis of neurological disorders. However, the low signal-to-noise ratio (SNR) of EEG signals and inter-subject variability present significant obstacles to developing robust and generalizable models.

Traditional approaches to EEG analysis often neglect individual differences, leading to models that perform well on the training data but fail to generalize to new subjects. To address this, researchers have explored various techniques, including linear models [1] and convolutional networks [2], to improve the generalization capability of EEG models. Despite these efforts, they discard the original image information, and converting the EEG signals of one individual to another remains a challenging task due to the noisy nature of the data.

In recent years, image denoising and high-quality image reconstruction vision have witnessed significant advancements with the introduction of Swin Transformer[3]. This hierarchical vision transformer efficiently handles high-resolution images through a combination of local and global self-attention mechanisms. Inspired by the success of Swin Transformer, we propose a novel approach to EEG signal conversion, leveraging the strengths of contrastive learning and image reconstruction models.

We propose SwinEEG[1], an individual-to-individual EEG converter that considers both image stimuli and source subject's EEG to learn the neural representation mapping from one subject to another. Through contrastive learning between EEG encoding and image stimulus encoding, the model can capture raw image features from EEG simultaneously, while the EEG generator ensures the quality of the brain signals. Experiments on the THINGS EEG2 dataset [4] demonstrate the effectiveness of SwinEEG in learning inter-subject neural representation mappings, as shown in Fig. 2, where the av-
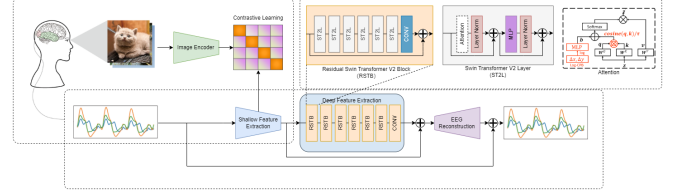
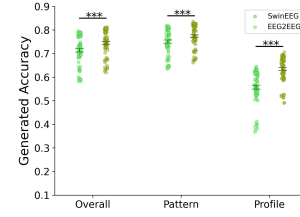**Fig. 1**. An overview of our SwinEEG framework.

Fig. 2. Comparison of the accuracy of our SwinEEG model and the EEG2EEG model [2] under different settings.

erage conversion performance in the overall setting improves from 71.2 to 74.3 compared to previous methods. The experimental results reflect the potential of SwinEEG in addressing the challenges of individual differences and noise in EEG.

2. REFERENCES

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[4] Alessandro T Gifford, Kshitij Dwivedi, Gemma Roig, and Radoslaw M Cichy, "A large and rich eeg dataset for modeling human visual object recognition," *NeuroImage*, vol. 264, pp. 119754, 2022.

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[1]Our code is publicly available at https://github.com/yerayl/SwinEEG.